



Horizontal Scroll compressors for Transport Air-Conditioning

ZRH49KJE to ZRH72KJE, ZBH30KJE to
ZBH45KJE, ZRHV72KJE and ZHV45KJE.

Application Guidelines



EMERSON
Climate Technologies

1	Safety instructions.....	1
1.1	Icon explanation	1
1.2	Safety statements.....	1
1.3	General instructions.....	2
2	Product description	2
2.1	Common information about Copeland Scroll™ compressors.....	2
2.2	About this guideline	2
2.3	Nomenclature	3
2.4	Application range.....	3
2.4.1	<i>Qualified refrigerants and oils.....</i>	3
2.4.2	<i>Application limits</i>	3
3	Installation	4
3.1	Compressor handling	4
3.1.1	<i>Transport and storage.....</i>	4
3.1.2	<i>Positioning and securing</i>	4
3.1.3	<i>Installation location.....</i>	5
3.1.4	<i>Mounting parts</i>	5
3.2	Brazing procedure	5
3.3	Shut-off valves and adaptors	6
3.4	Accumulators.....	7
3.5	Mufflers.....	7
4	Electrical connection.....	8
4.1	General recommendations	8
4.2	Electrical installation	8
4.2.1	<i>Cable connectors</i>	8
4.2.2	<i>Terminal box</i>	8
4.2.3	<i>Motor winding.....</i>	8
4.2.4	<i>Protection devices</i>	8
4.3	Inverter operation	9
4.4	Crankcase heater	9
4.5	Pressure safety controls	9
4.5.1	<i>High-pressure control.....</i>	9
4.5.2	<i>Low-pressure control.....</i>	10
4.6	Discharge temperature protection.....	10
4.7	Motor protection.....	11
4.8	High potential testing	11
5	Starting up & operation	12
5.1	Strength pressure test	12
5.2	Tightness/pressure test	12
5.3	Preliminary checks – Pre-starting	12



5.4 First start	12
5.5 Charging procedure	13
5.6 Rotation direction	13
5.7 Minimum run time	13
5.8 Pump-down cycle	13
6 Maintenance & repair	14
6.1 Exchanging the refrigerant	14
6.2 Replacing a compressor	14
6.2.1 <i>Compressor replacement</i>	14
6.2.2 <i>Start-up of a new or replacement compressor</i>	14
6.3 Lubrication	14
6.4 Compressor functional check	15
6.5 Unbrazing system components	16
7 Dismantling & disposal	16

1 Safety instructions

These compressors are constructed according to the latest European and US Safety Standards. Particular emphasis has been placed on the user's safety. Certain residual hazards from the compressor are not avoidable.

These compressors are intended for installation in systems according to the EC Machines directive. They may be put to service only if they have been installed in these systems according to instructions and conform to the corresponding provisions of legislation. For relevant standards please refer to Manufacturers Declaration, available on request.

These instructions should be retained throughout the lifetime of the compressor.

You are strongly advised to follow these safety instructions.

1.1 Icon explanation

WARNING 	This icon indicates instructions to avoid personal injury and material damage.	CAUTION 	This icon indicates instructions to avoid property damage and possible personal injury.
High Voltage 	This icon indicates operations with a danger of electric shock.	IMPORTANT 	This icon indicates instructions to avoid malfunction of the compressor.
Danger of burning or frostbite 	This icon indicates operations with a danger of burning or frostbite.	NOTE	This word indicates a recommendation for easier operation.
Explosion Hazard 	This icon indicates operations with a danger of explosion.		

1.2 Safety statements

- Refrigerant compressors must be employed only for their intended use.
- Only qualified and authorized HVAC or refrigeration personnel are permitted to install, commission and maintain this equipment.
- Electrical connections must be made by qualified electrical personnel.
- All valid standards for connecting electrical and refrigeration equipment must be observed.



Use personal safety equipment. Safety goggles, gloves, protective clothing, safety boots and hard hats should be worn where necessary.

1.3 General instructions



WARNING

System breakdown! Personal injuries! Never install a system in the field and leave it unattended when it has no charge, a holding charge, or with the service valves closed without electrically locking out the system.

System breakdown! Personal injuries! Only approved refrigerant and refrigeration oils must be used.

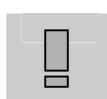


High shell temperature! Burning! Do not touch the compressor until it has cooled down. Ensure that other materials in the area of the compressor do not get in touch with it. Lock and mark accessible sections.



CAUTION

Overheating! Bearing damage! Do not operate compressors without refrigerant charge or without being connected to the system.



IMPORTANT

Transit damage! Compressor malfunction! Use original packaging. Avoid collisions and tilting.

2 Product description

2.1 Common information about Copeland Scroll™ compressors

The scroll compressor has been under development at Copeland since 1979. It is the most efficient and durable compressor Copeland has ever developed for air conditioning and refrigeration.

This application guideline deals with air-conditioning Copeland Horizontal Scroll™ compressors, ZRH49KJE to ZRH72KJE, ZBH30KJE to ZBH45KJE, ZRHV72KJE and ZBHV45KJE.

2.2 About this guideline

This guideline is intended to enable users to ensure the safe installation, starting, operation and maintenance of the scroll compressors.

This guideline is not intended to replace the system expertise available from system manufacturers.

For additional information, please refer to the "Product Catalogue" or to the "Copeland Selection Software" accessible from the Copeland website at www.ecopeland.com.

2.3 Nomenclature

The model designation contains the following technical information about the compressor:

Z R H V 72K J E - TFD - 650

Bill of material number
Motor version
Oil type: E = POE oil None = mineral oil
Model variation
Nominal capacity [BTU/h] @ 60 Hz and ARI conditions
V = Variable speed None = Fixed speed
Horizontal orientation
Application range temperature: R = air conditioning B = high/medium with sight glass & schraeder connection
Compressor family: Z = Scroll

C_T_ZRH_007

Safety
instructions

Product
description

Installation

Electrical
connection

Starting up &
operation

Maintenance &
repair

Dismantling &
disposal

2.4 Application range

2.4.1 Qualified refrigerants and oils



IMPORTANT

It is essential that the glide of refrigerant blends (primarily R407C) is carefully considered when adjusting pressure and superheat controls.

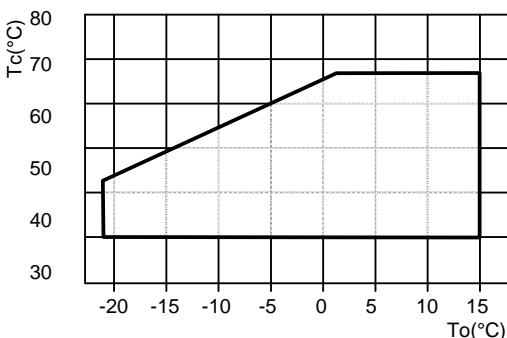
Oil recharge values can be taken from Copeland brochures or Copeland Selection Software.

Qualified refrigerant	R407C and R134a
Copeland standard oil	ICI Emkarate RL 32 – 3MAF
Servicing oil	ICI Emkarate RL 32 – 3MAF Mobil EAL Arctic 22 CC

Table 1

2.4.2 Application limits

R407C(mid-point)



R134a

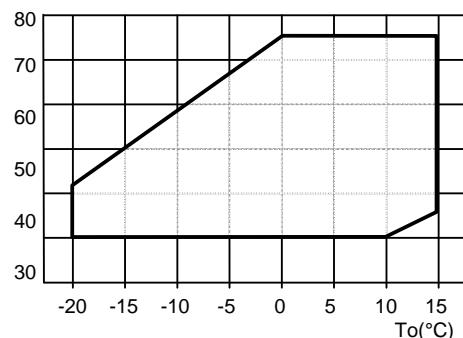


Figure 1: ZRH* & ZBH* envelopes with 10K suction superheat

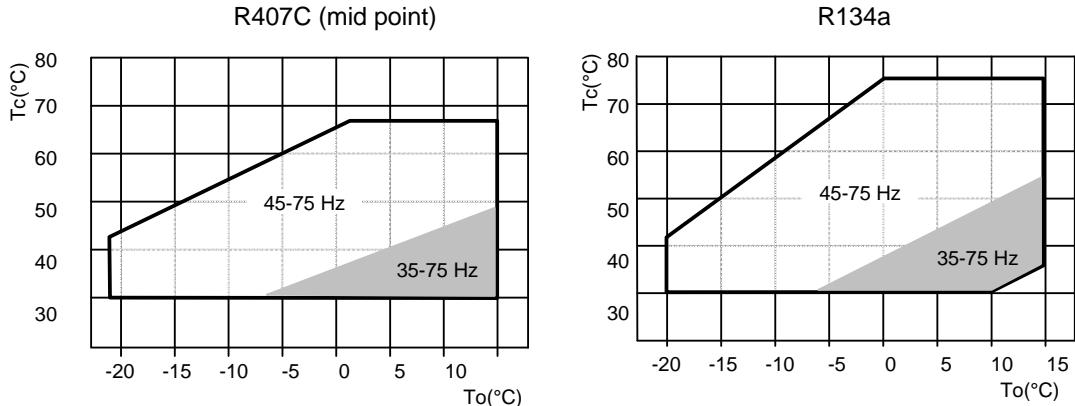


Figure 2: ZRHV72* & ZBHV45* envelopes with 10K suction superheat

3 Installation



WARNING

High pressure! Injury to skin and eyes possible! Be careful when opening connections on a pressurized item

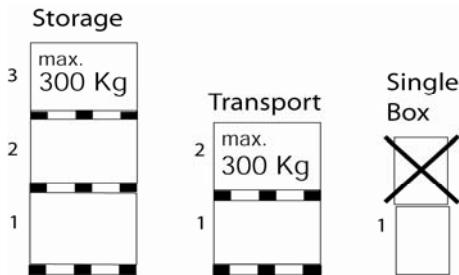
3.1 Compressor handling

3.1.1 Transport and storage



WARNING

Risk of collapse! Personal injuries! Move compressors only with appropriate mechanical or handling equipment according to weight. Keep in the upright position. Stack pallets on top of each other when not exceeding 300 kg. Do not stack single boxes on top of each other. Keep the packaging dry at all times.



3.1.2 Positioning and securing



IMPORTANT

Handling damage! Compressor malfunction! Only use the lifting eyes whenever the compressor requires positioning. Using discharge or suction connections for lifting may cause damage or leaks.

Positioned on the topside of the compressor shell end caps are lifting tabs. It is very important to utilize these lifting devices to maintain the compressor in the horizontal position during the installation and removal. Otherwise, damage to the compressor could occur.

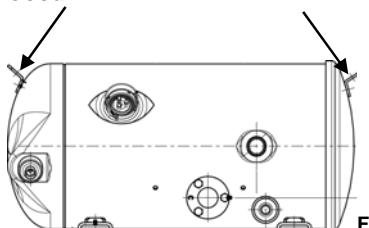


Figure 3

NOTE: Keep the compressor upright during installation and removal; otherwise oil could spill out of the suction tube.

3.1.3 Installation location

Ensure the compressors are installed on a solid level base.

3.1.4 Mounting parts

Four vibration absorber grommets are supplied with each compressor. They dampen the start-up surge of the compressor and minimise sound and vibration transmission to the compressor base during operation. The metal sleeve inside is a guide designed to hold the grommet in place. It is not designed as a load-bearing member, and application of excessive torque to the bolts can crush the sleeve. Its inner diameter is approximately 8.5 mm to fit, eg, an M8 screw. The mounting torque should be 13 ± 1 Nm. It is critically important that the grommet is not compressed. A clearance space of approximately 2 mm between the bottom of the washer and the top of the grommet spacer is recommended.

NOTE: Use the advised torque below to prevent from crushing the sleeve.

Bolt	M 8
Mounting torque	13 ± 1 Nm.

Table 2

The metal sleeve inside helps to hold the grommet in place.

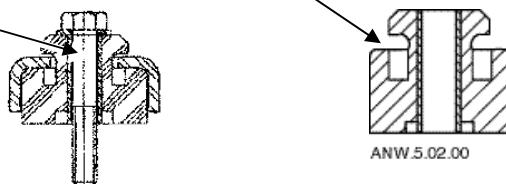


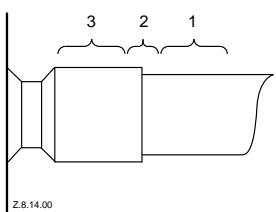
Figure 4

3.2 Brazing procedure

IMPORTANT

Blockage! Compressor breakdown! Maintain a flow of oxygen-free nitrogen through the system at very low pressure during brazing. Nitrogen displaces the air and prevents the formation of copper oxides in the system. If allowed to form, the copper oxide material can later be swept through the system and block screens such as those protecting capillary tubes, thermal expansion valves, and accumulator oil return holes.

Contamination or moisture! Bearing failure! Do not remove the plugs until the compressor is set into the unit. This minimises any entry of contaminants and moisture, especially if the compressor is charged with POE oil that is very hygroscopic.



Copeland Scroll™ compressors have copper-plated steel suction- and discharge tubes. These tubes are far more robust and less prone to leaks than copper tubes. Due to the different thermal properties of steel and copper, brazing procedures may have to be changed from those commonly used.

Figure 5: Suction tube brazing

Fig. 5 shows the proper procedure for brazing the suction and discharge lines to a scroll compressor.

- The copper-coated steel tubes on scroll compressors can be brazed in approximately the same manner as any copper tube.
Recommended brazing materials: any silfos material is recommended, preferably with a minimum of 5% silver. However, 0% silver is acceptable.
- Be sure tube fitting inner diameter and tube outer diameter are clean prior to assembly.
- Using a double-tipped torch, apply heat in area 1.
- As the tube approaches brazing temperature, move the torch flame to area 2.
- Heat area 2 until braze temperature is attained, moving the torch up and down and rotating around the tube as necessary to heat the tube evenly. Add braze material to the joint while moving the torch around the joint to flow braze material around the circumference.
- After the braze material flows around the joint, move the torch to heat area 3. This will draw the braze material down into the joint. The time spent heating area 3 should be minimal.
- As with any brazed joint, overheating may be detrimental to the final result.

To disconnect:

- Heat joint areas 2 and 3 slowly and uniformly until the braze material softens and the tube can be pulled out of the fitting.

To reconnect:

- Recommended brazing materials: Silfos with minimum 5% silver or silver braze used on other compressors. Due to the different thermal properties of steel and copper, brazing procedures may have to be changed from those commonly used.

Since the discharge stub contains a check valve, care must be taken not to overheat it to prevent brazing material to flow into it.

3.3 Shut-off valves and adaptors



CAUTION

Leaking system! System breakdown! It is strongly recommended to periodically re-torque all pipe and fixing connections to the original setting after the system has been put into operation.

Copeland Horizontal Scroll™ compressors are provided either with stub or Rotalock connections depending on the bill of material selected.

Rotalock shut-off valves are available for the suction as well as discharge side. Using either straight or angled adaptors provides a way to convert a Rotalock into a brazing connection.

Refer to the following table for proper tightening torques:

Torque [Nm]	
Rotalock 1"-14UNS	70-80
Rotalock 1"1/4-12UNF	110-135
Rotalock 1"3/4-12UNF	135-160

C_T_ZBH_002

Table 3

NOTE: More information concerning adaptors and shut-off valves can be found in the "Spare parts list".

3.4 Accumulators


CAUTION

Inadequate lubrication! Bearing destruction! Minimise liquid refrigerant returning to the compressor. Too much refrigerant dilutes the oil. Liquid refrigerant can wash the oil off the bearings leading to overheating and bearing failure.


CAUTION

Screen blocking! Compressor breakdown! Use screens with at least 0.6 mm openings (30 x 30 meshes per inch). Screens with a finer mesh can easily become plugged causing oil starvation to the compressor bearings. A compressor breakdown may be the consequence.

Irrespective of system charge, oil dilution may occur when large amounts of liquid refrigerant repeatedly flood back to the compressor during:

- normal off cycles
- defrost
- varying loads

To determine if an accumulator is required, refer to Technical Information "Excessive Liquid Floodback Tests".

If an accumulator must be used, an oil return orifice size in the range of 1.4 mm in diameter is recommended.

If an accumulator is used it is recommended that it be sized to hold from 50% to 70% of the system charge.

If an accumulator is fitted, and there is no crankcase heater, it should be piped to allow free liquid drainage during the off cycle.

A large area protective screen no finer than 30 x 30 mesh (0.6 mm openings) is required to protect this small orifice from plugging with system debris.

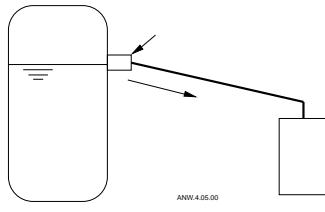


Figure 6: Suction accumulator installation

Tests have shown that a small screen with a fine mesh can easily become plugged causing oil starvation to the compressor bearings. Such blockage can result in compressor failure.

3.5 Mufflers

External mufflers, normally applied to piston compressors in the past, may not be required for Copeland Scroll™ compressors.

Individual system tests should be performed to verify acceptability of sound performance. If adequate attenuation is not achieved, use a muffler with a larger cross-sectional area to inlet area ratio. A ratio of 20:1 to 30:1 is recommended.

A hollow shell muffler will work quite well. Locate the muffler at minimum 15 to maximum 45 cm from the compressor for the most effective operation. The farther the muffler is placed from the compressor within these ranges, the more effective it is. Choose a muffler with a length of 4 to 10-15 cm.

4 Electrical connection

4.1 General recommendations

The compressor terminal box has a wiring diagram on the inside of its cover. Before connecting the compressor, ensure the supply voltage, the phases and the frequency match the nameplate data.

Compressors can be delivered with various types of connection depending on the bill of material:

- For 1/4" standard flag connectors
- For a push-on molded plug

4.2 Electrical installation

The motor insulation material is class "B" for compressor models covered in this guideline. This is according to IEC 34-1 or DIN 57530.

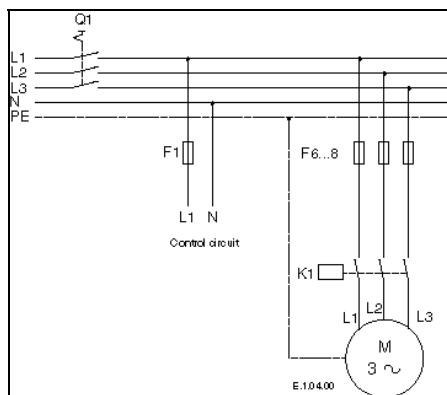


Figure 7: Power circuit three-phase compressor

4.2.1 Cable connectors

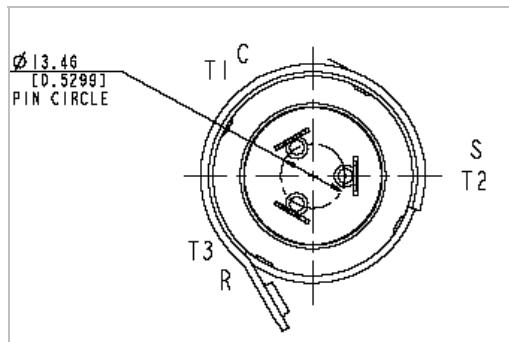


Figure 8

Compressors are delivered with a Domed Cover IP21 for 1/4" spade connectors (BOM 540, 541). Another connection option is available on request.

Cable sizes are to be selected according to DIN ISO 0100, IEC 364 or national regulations.

4.2.2 Terminal box

The terminal box is IP21 for all models.

4.2.3 Motor winding

All three-phase motors are connected in star.

4.2.4 Protection devices

Independently from the internal motor protection, fuses must be installed before the compressor. Selection of fuses has to be carried out according to VDE 0635, DIN 57635, IEC 269-1 or EN 60-269-1.

4.3 Inverter operation

Since Copeland Horizontal Scroll™ compressors are designed for mobile air conditioning applications, they can operate on inverter-derived power. The ZRH and ZBH compressors are limited to fixed speed operation at either 50 or 60 Hz.

The variable speed ZRHV and ZBHV Copeland Horizontal Scroll™ compressors can be operated over the range of 35-75 Hz. The value of the voltage should be 7.67 multiplied by the operating frequency over the range of 35 to 60 Hz. From 60 to 75 Hz, the voltage should be a constant 460 volts. Matching voltage to frequency according to this guideline will prevent motor saturation and overheating.

Inverter drives used to power Copeland Horizontal Scroll™ compressors must comply with the provisions of IEC Technical Specification 600034-17. In particular, the motor input voltage must be limited to 1.35 kV/microsecond line-to-line impulse voltage. These provisions are required to avoid motor insulation breakdown, to limit motor heating, and to prolong motor life.

4.4 Crankcase heater



CAUTION

The initial start in the field is a very critical period for any compressor because all load bearing surfaces are new and require a short break-in period to carry high loads under adverse conditions.

A crankcase heater is necessary if the system configuration enables large amounts of refrigerant to condense in the compressor and be absorbed by the oil during standstill period. It is required when the system charge exceeds 4.5 kg.

The wrap-around band heater should be positioned between the left-hand side of the oil sight glass and the electrical box.

The crankcase heater must be turned on a minimum of 12 hours prior to starting the compressor and must remain energized during the compressor off cycle.

Crankcase heaters are normally the most effective means of keeping liquid refrigerant out of the compressor oil during off cycles. In rail applications, crankcase heaters are not effective since typically there will be no voltage present during extended off cycle periods.

A check valve in the discharge line along with a liquid line solenoid valve should be used to limit off cycle migration to the compressor. The low leak check valve must be qualified for discharge line service. A pump down cycle may be another option to limit migration.

4.5 Pressure safety controls

Copeland Horizontal Scroll™ compressors comply with the European Pressure Equipment Directive (PED) 97/23/EC. Both high- and low-pressure controls are required and should be wired in series with the compressor contactor coil power supply. If a micro-processor control is used, it may monitor and lock out after a limited number of trips.

4.5.1 High-pressure control

Copeland Horizontal Scroll™ compressors do not have internal pressure relief valves. To ensure safe operation, a high-pressure control must be used in all applications.

The high-pressure control should have a manual reset feature for the highest level of system protection.

If the compressor is fitted with a Rotalock valve, the high-pressure switch MUST be connected on the compressor side of the valve.

The high-pressure maximum is 29 bar(g) (R407C) and 23.5 bar(g) (R134a).

4.5.2 Low-pressure control



IMPORTANT!

Loss of system charge! Bearing malfunction! A low-pressure control is highly recommended for loss of charge protection. Do not bridge or by-pass the low-pressure cut out.

Copeland Horizontal Scroll™ compressors require a low-pressure control for loss of charge protection. If allowed to go undetected, loss of system charge will result in overheating and damage to the scrolls and floating seal. Prolonged operation with low charge will result in decomposition of the oil that might require complete system replacement.

The low-pressure cut out, if installed in the suction line to the compressor, can provide additional protection against a TXV failed in the closed position, a closed liquid line service valve, or a blocked liquid line screen, filter, orifice, or TXV. All of these conditions can starve the compressor for refrigerant and may result in compressor failure.

The low-pressure cut out should have a manual reset feature for the highest level of system protection.

If a compressor is allowed to cycle after a fault is detected, there is a high probability that the compressor will be damaged and the system contaminated with debris from the failed compressor and decomposed oil.

If the compressor is fitted with a Rotalock valve, the low-pressure switch MUST be connected on the compressor side of the valve.

The low-pressure cut out should be set as high as possible.

The low-pressure minimum is 1.8 bar(g) (R407C) and 0.3 bar(g) (R134a).

4.6 Discharge temperature protection

Internal discharge temperatures reached under some extreme operating conditions can cause compressor damage. Extreme operating conditions are, for example, loss of charge, extremely high compression ratio caused by failure of evaporator fan...

Copeland Horizontal Scroll™ compressors have no internal scroll temperature protection. As a result, an external discharge line sensor is required for all refrigeration and heat pump applications to provide loss-of-charge protection. This is due to the very low setting required on the low-pressure cut outs of these systems due to their evaporating temperatures. Air conditioning systems do not always need the discharge line sensor.

The discharge line sensor is normally not required for loss of charge protection when a low-pressure cut out with a setting of 1.7 bar(g) (1.8 kg/cm²) or higher can be installed directly on the suction line of the compressor.

The following loss-of-charge test is recommended for air conditioning systems to confirm that the existing low-pressure control provides the necessary protection:

- Operate the system in a 35°C ambient and monitor discharge line temperature while slowly removing charge.
- If the discharge line temperature, measured using an insulated thermocouple located 6 inches (15 cm) from the compressor, does not exceed 127°C before the low-pressure cut out trips, then the system has adequate loss-of-charge protection. In this case, an external discharge line sensor is not necessary.
- If the test shows that the discharge temperature gets into the danger zone, then Copeland recommends the use of a thermistor sensor strapped to the discharge line and insulated to provide discharge temperature protection. The system controller must lock out the compressor if the thermistor temperature exceeds 127°C. As with the low-pressure cut out, the discharge temperature protection should have a manual reset feature for the highest level of protection. A minimum thirty-minute lockout period should be provided for any discharge temperature trip.

Discharge line thermostats - available from Copeland - will provide adequate temperature protection in fixed applications.

Install the thermostat approximately 120 mm from the discharge valve outlet.

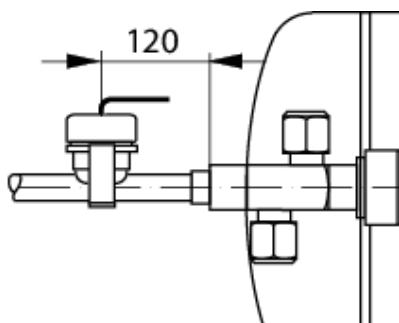


Figure 9

In order to avoid improper functioning due to false readings, this thermostat needs to be insulated.

4.7 Motor protection

Conventional inherent internal line break motor protection is provided with all compressor models covered in this guideline.

The protector reacts to a combination of motor current and motor winding temperature. The internal protector protects against single phasing. Time must be allowed for the motor to cool down before the protector will reset.

4.8 High potential testing



WARNING

Conductor cables! Electrical shock! Shut off power supply before high-potential testing.



CAUTION

Internal arcing! Motor destruction! Do not carry out high-voltage or insulation tests if the compressor housing is under vacuum.

Copeland subjects all scroll compressors to a high-voltage test after final assembly. The test is carried out according to EN 0530 or VDE 0530 part 1. Since high-voltage tests lead to premature aging of the winding insulation further additional tests of that nature are not recommended.

A high-potential test is usually conducted on the production line by the manufacturer. This test can be conducted in the field; however, field technicians typically do not have the required equipment.

Copeland Horizontal ScrollTM compressors are configured with the motor at the same level as the pumping components. As a result, the motor can be immersed in oil and refrigerant to a greater extent than hermetic reciprocating compressors when liquid refrigerant is present in the shell. In this respect, the horizontal scroll is more like semi-hermetic compressors which can have horizontal motors partially submerged in oil and refrigerant. When Copeland ScrollTM compressors are Hipot tested with liquid refrigerant in the shell, they can show higher levels of current leakage than compressors with the motor on top. This phenomenon can occur with any compressor when the motor is immersed in refrigerant. The level of current leakage does not present any safety issue. To lower the current leakage reading, the system should be operated for a brief period of time to redistribute the refrigerant to a more normal configuration and the system should be Hipot tested again. See AE Bulletin 4-1294 for Megohm testing recommendations. Under no circumstances should the Hipot test be performed while the compressor is under a vacuum.

5 Starting up & operation

**WARNING**

Diesel effect! Compressor destruction! The mixture of air and oil at high temperature can lead to an explosion. Avoid operating with air.

**IMPORTANT**

Oil dilution! Bearing malfunction! Turn the crankcase heater on 12 hours before starting the compressor.

5.1 Strength pressure test

The compressor has been strength-tested in the factory. It is not necessary for the customer to strength- or leak-test the compressor again although the compressor will normally be exposed to the testing made as part of system testing.

5.2 Tightness/pressure test

**CAUTION**

Consider personal safety requirements and refer to test pressures prior to test.

**CAUTION**

System contamination! Bearing malfunction! Use only dry nitrogen or dried air for pressure testing.

**WARNING**

System explosion! Personal injuries! DO NOT USE other industrial gases.

If using dry air do not include the compressor in the pressure test – isolate it first. Never add refrigerant to the test gas (as leak indicator).

5.3 Preliminary checks – Pre-starting

**WARNING**

Vacuum operation! Compressor damage!

Discuss details of the installation with the installer. If possible, obtain drawings, wiring diagrams, etc.

Prior to commissioning the system, the low-pressure switch has to be set and its operation tested otherwise when starting up if there is a shortage of refrigerant the scroll compressor can pull a high vacuum that will severely damage the motor and compressor.

It is ideal to use a check-list but always check the following:

- Visual check of the electrics, wiring, fuses etc.
- Visual check of the plant for leaks, loose fittings such as TXV bulbs etc.
- Compressor oil level
- Calibration of HP & LP switches and any pressure actuated valves
- Check setting and operation of all safety features and protection devices
- All valves in the correct running position
- Pressure and compound gauges fitted
- Correctly charged with refrigerant
- Compressor electrical isolator location & position

5.4 First start

It is good practice to stop the compressor after 15 minutes running on full or part load then check the oil levels in both sight glasses. The oil levels should be half way up the sight glasses. This is to ensure that any oil carried over into the system is being returned to the compressor and the compressor is not short of oil.

5.5 Charging procedure

It is considered good practice when charging a system to charge liquid refrigerant into the high side and vapour charge the low side of the system.

An alternative method is for liquid to be charged through the liquid receiver shut-off valve or through a valve in the liquid line.

The use of a filter drier in the charging line is highly recommended.

It is not good for any compressor to have liquid refrigerant dumped from a refrigerant cylinder into the crankcase of the compressor.

5.6 Rotation direction

Scroll compressors, like several other types of compressors, will only compress in one rotational direction. Three-phase compressors will rotate in either direction depending upon phasing of the power. Since there is a 50-50 chance of connecting power in such a way as to cause rotation in the reverse direction, **it is important to include notices and instructions in appropriate locations on the equipment to ensure proper rotation direction when the system is installed and operated.**

Observing that suction pressure drops and discharge pressure rises when the compressor is energized allows verification of proper rotation direction. There is no negative impact on durability caused by operating three-phase Copeland Scroll™ compressors in the reversed direction for a short period of time (under one hour) but oil may be lost. Oil loss can be prevented during reverse rotation if the tubing is routed at least 15 cm above the compressor. After several minutes of operation in reverse, the compressor protection system will trip due to high motor temperature. The operator will notice a lack of cooling. However, if allowed to repeatedly restart and run in reverse without correcting the situation, the compressor will be permanently damaged.

All three-phase scroll compressors are identically wired internally. Therefore, once the correct phasing is determined for a specific system or installation, connecting properly phased power leads to the identified compressor terminals will ensure proper rotation direction.

5.7 Minimum run time

There is no set answer to how often scroll compressors can be started and stopped in an hour, since it is highly dependent on system configuration. There is no minimum off time because scroll compressors start unloaded, even if the system has unbalanced pressures. The most critical consideration is the minimum run time required to return oil to the compressor after start-up. To establish the minimum run time obtain a sample compressor equipped with a sight glass (available from Copeland) and install it in a system with the longest connecting lines that are approved for the system. The minimum on time becomes the time required for oil lost during compressor start-up to return to the compressor sump and restore a minimal oil level that will ensure oil pick-up through the crankshaft. Cycling the compressor for a shorter period than this, for instance to maintain very tight temperature control, will result in progressive loss of oil and damage to the compressor.

5.8 Pump-down cycle

A pump-down cycle may be used for control of refrigerant migration. **If a pump-down cycle is used, a separate external check valve must be added to the discharge line** to prevent liquid refrigerant from returning to the compressor through the discharge line and also to prevent frequent recycling due to leak-back. The internal scroll discharge check valve is designed to stop extended reverse rotation and prevent high pressure gas from leaking rapidly into the low side after shut off.

If a microprocessor is used, the system can be set to pump down for a fixed number of seconds after the set point is reached and the liquid line solenoid valve is closed. The system should pump down until the pressure is close to the cut out pressure of the low-pressure switch. It is not

necessary to pump down into nearly a vacuum to remove all liquid refrigerant from the low side. If the low-pressure switch opens, the pump down should stop immediately.

Copeland Scroll™ compressors trap a considerable volume of high-pressure gas between the muffler plate and the top cap. When the compressor shuts down, the trapped gas will expand back into the suction side of the system. This frequently causes a pulse of pressure to propagate down the suction line and can cause the low-pressure switch to reset. The compressor must not be allowed to short cycle which may result in oil pump out.

6 Maintenance & repair

6.1 Exchanging the refrigerant

- Qualified Refrigerants and oils are given in section 2.4.1.

6.2 Replacing a compressor



CAUTION

Inadequate lubrication! Bearing destruction! Exchange the accumulator after replacing a compressor with a burned out motor. The accumulator oil return orifice or screen may be plugged with debris or may become plugged. This will result in starvation of oil to the new compressor and a second failure.

6.2.1 Compressor replacement

When a compressor is exchanged in the field, a major portion of the oil may remain in the system. While this may not affect the reliability of the replacement compressor, the extra oil will add to rotor drag and increase power usage. The compressor should be run for 10 minutes, shut down and the extra oil removed via the Schrader when fitted (only ZBH). This operation should be repeated at least twice to make sure the proper oil level has been achieved. The oil level should be maintained at midpoint of the sight glass.

In the case of a motor burn out, the majority of contaminated oil will be removed with the compressor. The rest of the oil is cleaned through the use of suction and liquid line filter driers. A 100% activated alumina suction line filter drier is recommended but must be removed after 72 hours. **It is highly recommended that the suction accumulator be replaced if the system contains one.** This is because the accumulator oil return orifice or screen may be plugged with debris or may become plugged shortly after a compressor failure. This will result in starvation of oil to the replacement compressor and a second failure.

6.2.2 Start-up of a new or replacement compressor

Do not start the compressor while the system is in a deep vacuum. Internal arcing may occur when a scroll compressor is started in a vacuum.

Do not operate compressor without enough system charge to maintain at least 0.5 bar suction pressure. A minimum suction pressure of 1.75 bar must be maintained during charging. Allowing pressure to drop below 0.5 bar for more than a few seconds may overheat scrolls and cause early drive bearing damage.

Do not operate with a restricted suction port.

Do not operate with the low-pressure cut out bridged.

Never install a system in the field and leave it unattended when it has no charge, a holding charge, or with the service valves closed without securely locking out the system. This will prevent unauthorized personnel from accidentally operating the system and potentially ruining the compressor by operating with no refrigerant flow.

6.3 Lubrication



WARNING

Chemical reaction! Compressor destruction! Do not mix up ester oils with mineral oil and/or alkyl benzene when used with chlorine-free (HFC) refrigerants.

The compressor is supplied with an initial oil charge. In the field the oil level could be topped up with the recommended servicing oils (see section 2.4.1).

One disadvantage of POE is that it is far more hygroscopic than mineral oil (see **Fig. 10**). Only brief exposure to ambient air is needed for POE to absorb sufficient moisture to make it unacceptable for use in a refrigeration system. Since POE holds moisture more readily than mineral oil it is more difficult to remove it through the use of vacuum. Compressors supplied by Copeland contain oil with low moisture content, and it may rise during the system assembling process. Therefore it is recommended that a properly sized filter-drier is installed in all POE systems. This will maintain the moisture level in the oil to less than 50 ppm. If oil is charged into a system, it is recommended to use POE with a moisture content no higher than 50 ppm.

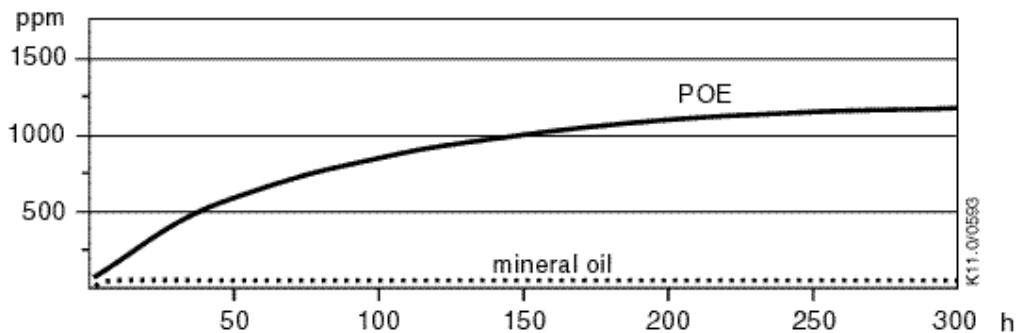


Figure 10: Absorption of moisture in ester oil in comparison to mineral oil in ppm by weight at 25°C and 50% relative humidity (h=hours)

If there is uncertainty as to the moisture content in the system, an oil sample should be taken and tested for moisture. Sight glass/moisture indicators currently available can be used with the HFC refrigerants and lubricants. The moisture indicator will just show the moisture contents of the refrigerant. The actual moisture level of POE would be higher than the sight glass specifies. This is a result of the high hygroscopicity of the POE oil. Oil samples would have to be taken from the system and analysed to determine the actual moisture content of the lubricant. If the moisture content of the oil in a refrigeration system reaches unacceptably high levels, corrosion and copper plating may occur.

Copeland Horizontal Scroll™ compressors are fitted with an internal oil pump.

Rotalock valves should be periodically re-torqued to ensure that leak tightness is maintained.

6.4 Compressor functional check

A functional compressor test with the suction service valve closed to check how low the compressor will pull suction pressure is **not** a good indication of how well a compressor is performing. **Such a test will almost certainly damage a scroll compressor.**

The following diagnostic procedure should be used to evaluate whether a Copeland Scroll™ compressor is working properly:

1. Proper voltage to the unit should be verified.
2. The normal checks of motor winding continuity and short to ground should be made to determine if the inherent overload motor protector has opened or if an internal motor short or ground fault has developed. If the protector has opened, the compressor must be allowed to cool sufficiently to allow it to reset.
3. Proper indoor and outdoor blower/fan operation should be verified.
4. With service gauges connected to suction and discharge pressure fittings, turn on the compressor. If suction pressure falls below normal levels, the system is either low on charge or there is a flow blockage in the system.
5. If suction pressure does not drop and discharge pressure does not rise to normal levels, reverse any two of the compressor power leads and reapply power to make sure compressor was not wired to run in reverse direction.
6. To test if the compressor is pumping properly, the compressor current draw must be compared to published compressor performance using the operating pressures and voltage of the system. If the measured average current deviates more than $\pm 15\%$ from published values, it may be an indication of a faulty compressor. A current imbalance exceeding 15% of the average on the three phases should be investigated further.

7. Before replacing or returning a compressor, make certain the compressor is actually defective. As a minimum, recheck a compressor returned from the field in the shop or depot for Hipot failure, winding resistance, and ability to start before returning. More than one third of compressors returned to Copeland for warranty analysis are determined to have nothing found wrong. They were mis-diagnosed in the field as being defective. Replacing working compressors unnecessarily costs everyone.
8. NEVER test a scroll compressor by closing the suction valve or the liquid feed to the evaporator and pumping the compressor into a vacuum.

6.5 Unbrazing system components



WARNING

Explosive flame! Burning! Oil-refrigerant mixtures are highly flammable. Remove all refrigerant before opening the system. Avoid working with an unshielded flame in a refrigerant charged system.

Before opening up a system it is important to remove all refrigerant from both the high and low sides of the systems. If the refrigerant charge is removed from a scroll-equipped unit from the high side only, it is possible for the scrolls to seal, preventing pressure equalization through the compressor. This may leave the low side shell and suction line tubing pressurized. If a brazing torch is then applied to the low side while the low side shell and suction line contain pressure, the pressurized refrigerant and oil mixture could ignite when it escapes and contacts the brazing flame. To prevent this occurrence, it is important to check both the high and low sides with manifold gauges before applying heat. Instructions should be provided in appropriate product literature and assembly (line repair) areas. If compressor removal is required, the compressor should be cut out of system rather than unbrazed.

7 Dismantling & disposal



- Removing oil and refrigerant:**
- Do not disperse it in the environment.**
- Use the correct equipment and method of removal.**
- Dispose oil and refrigerant properly.**
- Dispose the compressor properly.**

Benelux
 Deltakade 7
 NL-5928 PX Venlo
 Tel. +31 (0) 77 324 0234
 Fax +31 (0) 77 324 0235

UK & Ireland
 17 Theale Lakes Business Parc
 GB-Theale, Nr Reading-Berkshire RG 7 4GB
 Tel. +44 (0)1 189 83 8000
 Fax +44 (0)1 189 83 800 1

Asia/Pacific
 10/F, Pioneer Building, 213 Wai Yip Street,
 Kwun Tong, Kowloon - Hong Kong
 Tel. +852 28 66 31 08
 Fax +852 25 20 62 27

Deutschland/Österreich & Schweiz
 Senefelder Straße 3
 D-63477 Maintal
 Tel. +49 (0)6109 6059 0
 Fax +49 (0)6109 6059 40

Sweden/Denmark/Norway & Finland
 Pascalstr. 65
 D-52076 Aachen
 Tel. +49 (0) 2408 929 127
 Fax +49 (0) 2408 929 528

Latin America
 7975 North West 154Th Street - Suite 300
 Miami Lakes, FL, 33016 - USA
 Tel. +1 305 818 8880
 Fax +1 305 818 8888

France/Greece & Maghreb
 8, Allée Du Moulin Berger
 F-69130 Ecully
 Tel. +33 (0)4 78668570
 Fax +33 (0)4 78668571

Eastern Europe, Turkey
 Pascalstr. 65
 D-52076 Aachen
 Tel. +49 (0) 2408 929 0
 Fax +49 (0) 2408 929 525

Middle East & Africa
 PO BOX 26382, R/A 8, FD-2
 Jebel Ali, Dubai - UAE
 Tel. +9714 883 2828
 Fax +9714 883 2848

Italia
 Via Ramazzotti, 26
 I-21047 Saronno (va)
 Tel. +39 02 961781
 Fax +39 02 96178888

Poland
 11A, Konstruktorska
 PL-02-673 Warszawa
 Tel. +48 22 458 9205
 Fax +48 22 458 9255

España & Portugal
 Diputacion, 238 AT.8
 E-08007 Barcelona
 Tel. +34 93 4123752
 Fax +34 93 4124215

Russia & CIS
 Letnikovskaya, 10, building 2, 5th floor
 RUS-113114 Moscow
 Tel. +7 495 981 9811
 Fax +7 495 981 9816

Copeland®

Emerson Climate Technologies - European Headquarters - Pascalstrasse 65 - 52076 Aachen, Germany
 Phone: +49 (0) 2408 929 0 - Fax: +49 (0) 2408 929 570 - Internet: www.eCopeland.com


EMERSON™
 Climate Technologies

The Emerson Climate Technologies logo is a trademark and service mark of Emerson Electric Co. Copeland Corporation is a subsidiary of Emerson Electric Co. Copeland is a registered trademark and Copeland Scroll is a trademark of Copeland Corporation. All other trademarks are property of their respective owners. Information contained in this brochure is subject to change without notification.